

## Sea ice typical sizes

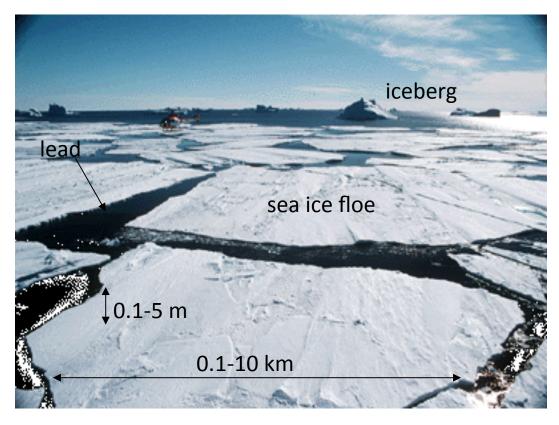
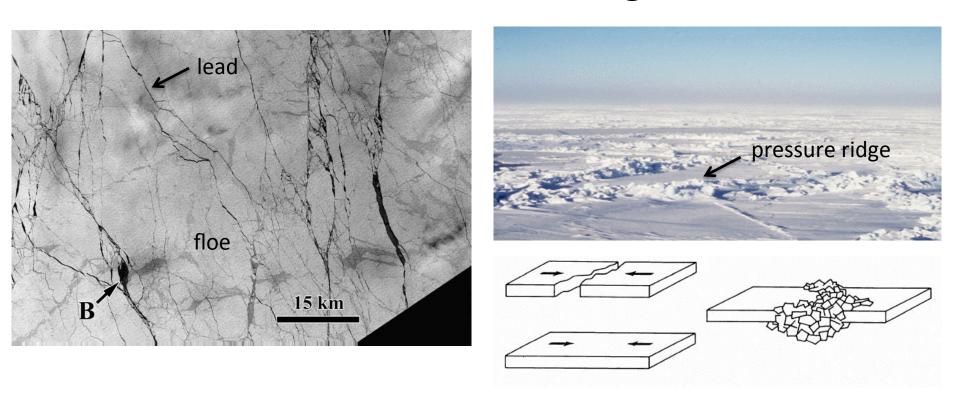


figure from D. Feltham

Consists of **floes** that are ~0.1-10 km wide and ~0.1-5 m thick; separated by cracks or **leads**. Floes may freeze together (healing) to form **floe aggregates**. Ice area concentration typically 20-99%.

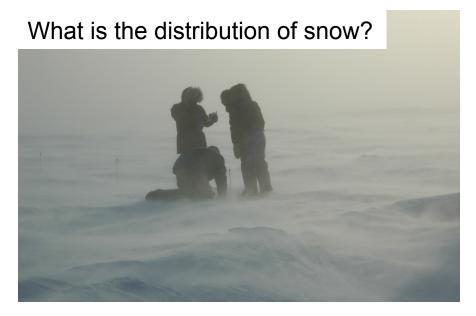
## Floes, leads, and ridges



**Pressure ridges** form when floes collide. The ice sheet breaks up into blocks that are pushed into **sails** and **keels**. Pressure ridges can be many kilometres in length.

# **Complex Variability**



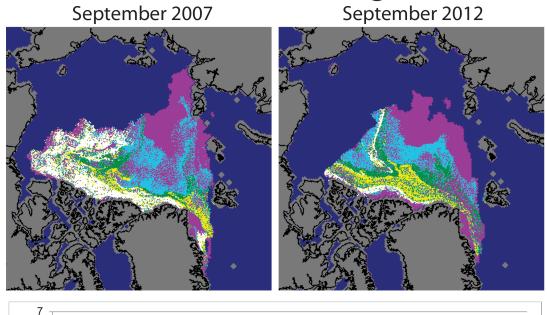


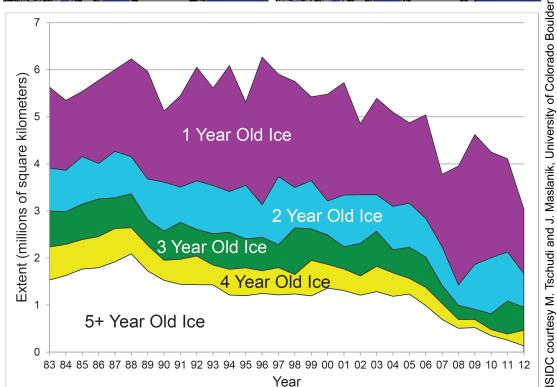




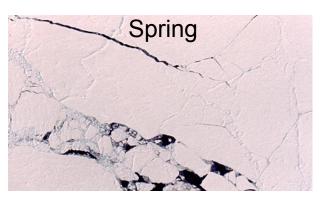
slide from D. Perovich

### Arctic Sea Ice Age



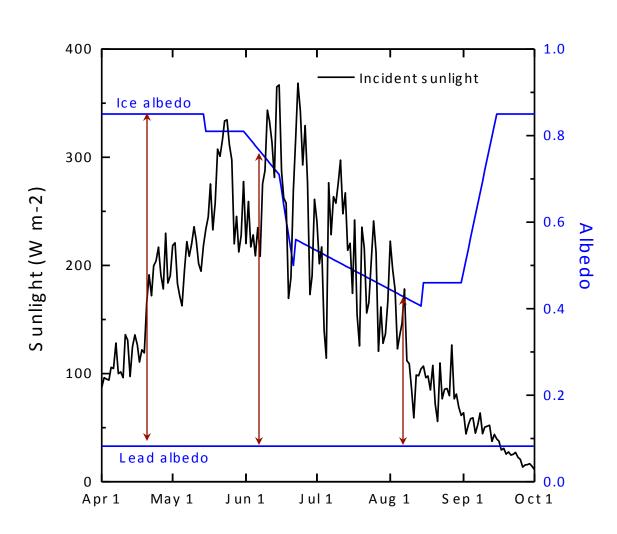


# Timing is everything: Impact of leads





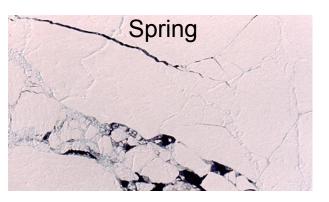




slide from D. Perovich

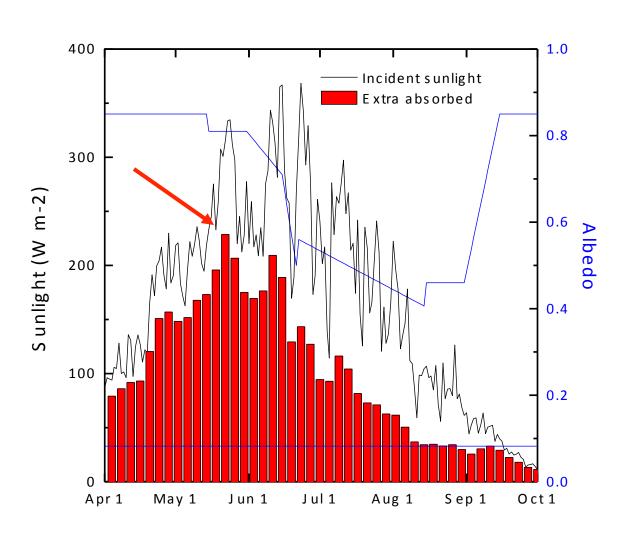
Need to adjust for the incident sunlight

# Timing is everything: Impact of leads



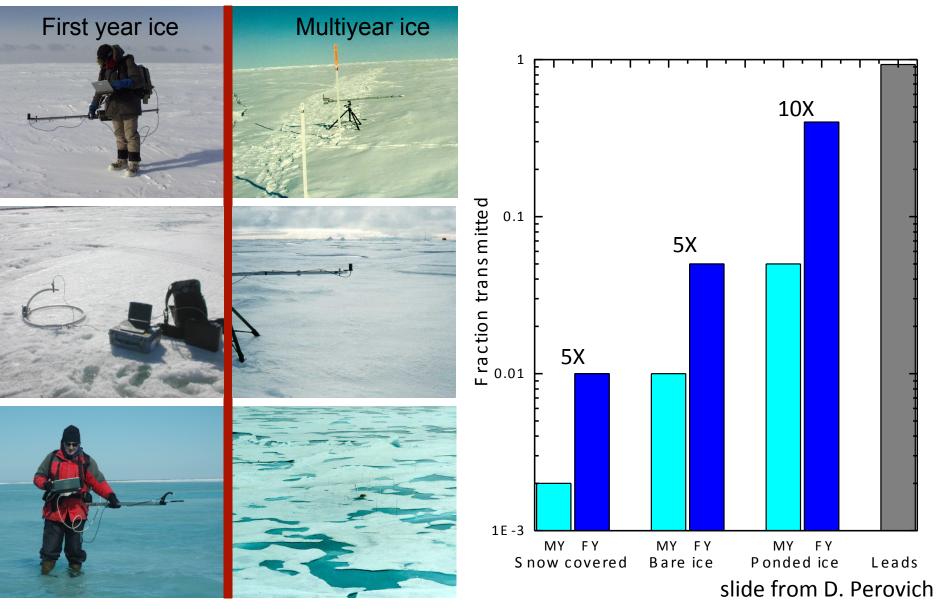






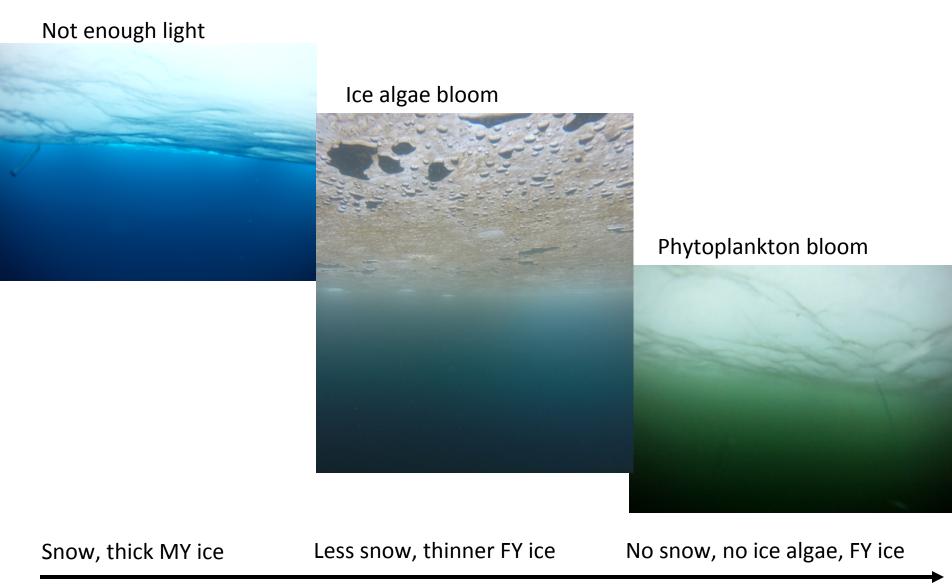
slide from D. Perovich

## Changing ice, changing light – FY vs. MY



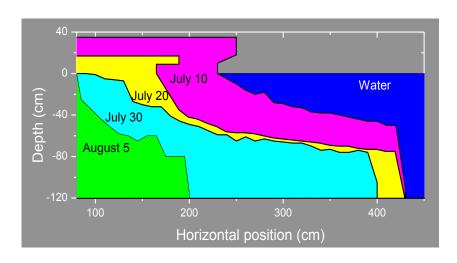
First year ice transmits much more sunlight to ocean

# As light transmission increases

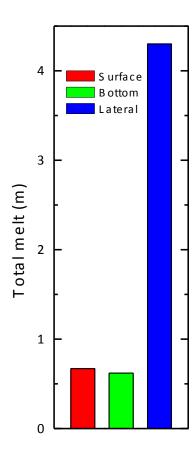


slide from D. Perovich

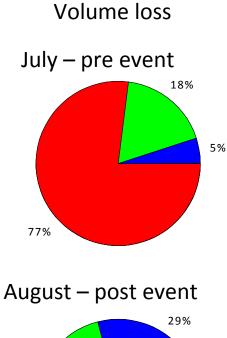
## Bottom vs. lateral melt

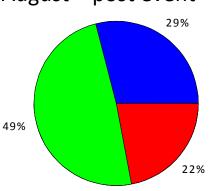




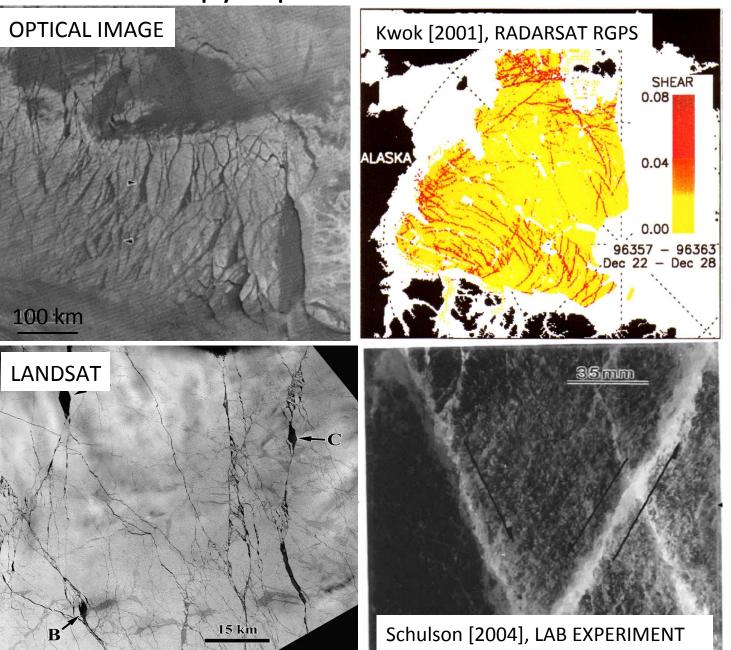


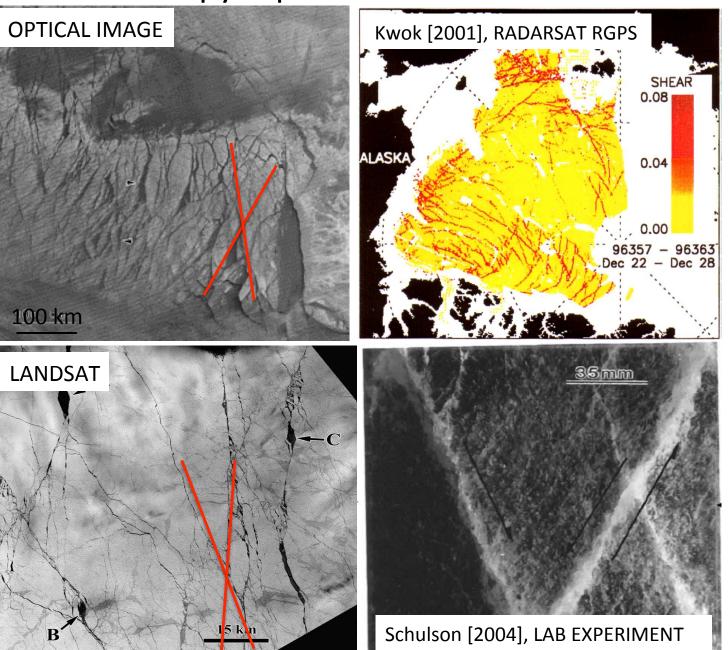
Total melt

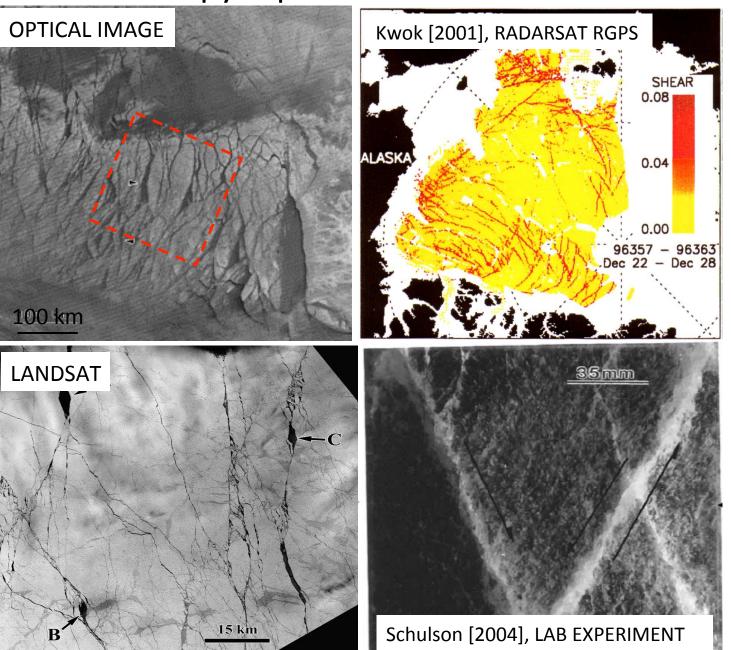


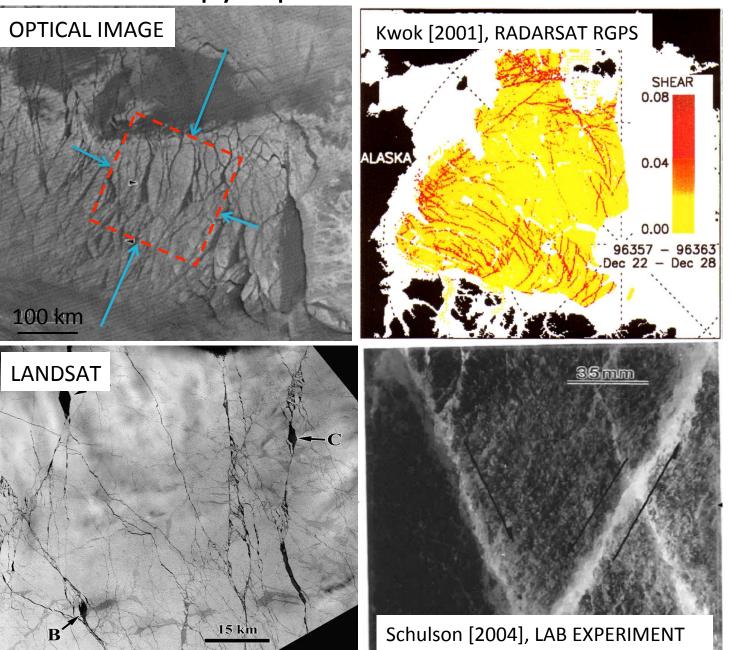


slide from D. Perovich



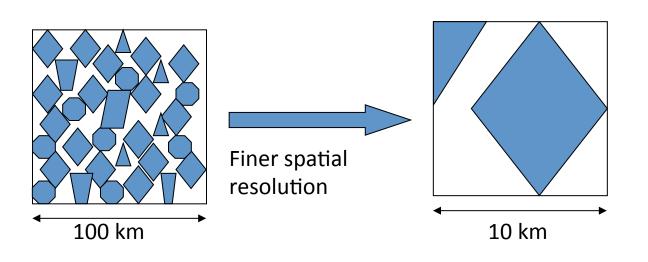






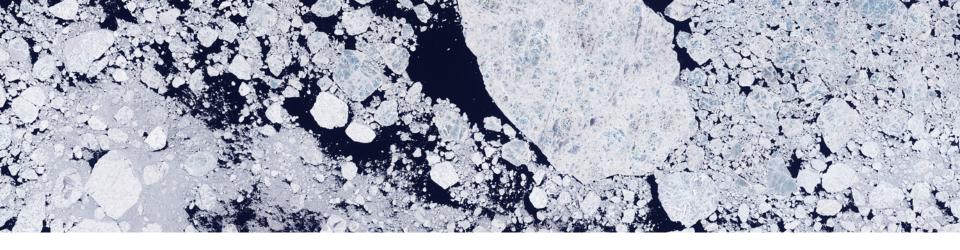
Ice cover is anisotropic (though not in ice models until recently). Has implications for ice stresses and so affects the momentum balance and thus every aspect of sea ice simulations.

If failure physics (cracking) is truly scale invariant and this physics is included in models then one might expect to recover the anisotropy by increasing the resolution. But there are floes ...



This cell only contains one complete floe.
A continuum model prediction may not be valid for this floe.

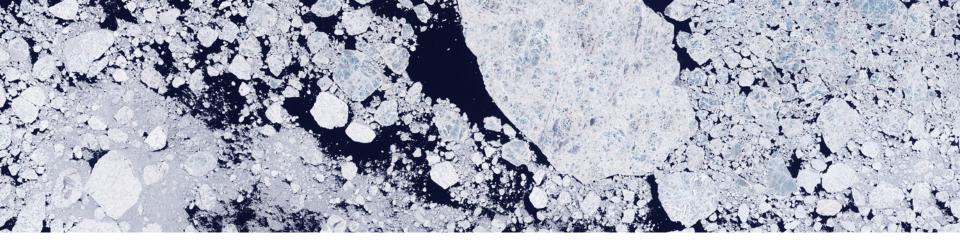
With isotropic physics, simulations at high spatial resolutions do not capture the observed failure patterns. Testing on anisotropic models in progress now.



Sea ice models at high resolution should simulate

- sea ice thickness distribution
- melt ponds
- floes size distribution
- anisotropy

Initialization for prediction: Under what conditions do properties that affect these items need to be initialized?

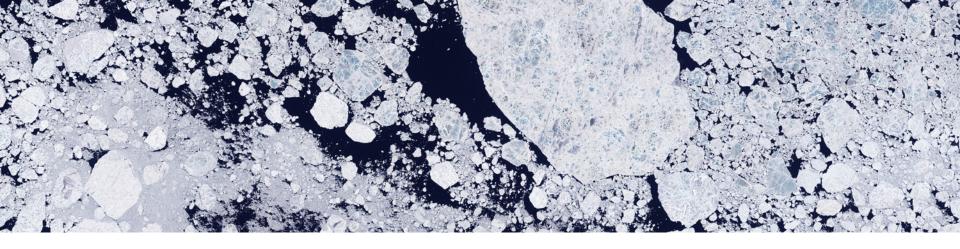


Sea ice models – autocorrelation timescales

- sea ice thickness distribution year or so
- melt ponds a few months
- floes size distribution a month? (my guess)
- anisotropy a week

#### Subseasonal forecast (2-3 weeks):

Initialized with the current thickness, concentration, and floe & melt pond size statistics. The key external conditions that will determine the fast evolution is wind anomalies, and to a lesser extent SST anomalies. Forecast is primarily a coupled atmosphere-ice problem (with correct SST ICs).



Sea ice models – autocorrelation timescales

- sea ice thickness distribution year or so
- melt ponds a few months
- floes size distribution a month? (my guess)
- anisotropy a week

#### Subseasonal-seasonal forecast (3-50 weeks):

Initialized with the current thickness, concentration, and floe & melt pond size statistics. The key external initial condition is ocean temperature. Forecast is a coupled atmosphere-ocean-ice problem.

#### Current state of sea ice initialization in subseasonal to decadal prediction

Climatology of last X years

Sea ice "along for ride" = ocean state estimate - ocean DA and prescribed atm

Sea ice DA coupled with ocean DA (atm prescribed or ideally coupled)
Sea ice DA is usually just sea ice concentration, though sea ice
thickness/freeboard probably would have a bigger impact.

#### Resolution of available observations for ICs

AMSR products horizontal ~6 km (I think)

Ice thickness (long story)

Ice ponds and floe size – nothing available beyond a few surveys